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**REGIONAL AND HEADQUARTERS QUESTIONS AND ANSWERS  
EPA's New Non-Cancer Toxicity Value for Dioxin  
Impact and Implementation at CERCLA and RCRA Sites**

**QUESTIONS AND ANSWERS**

**OVERVIEW**

- The U.S. Environmental Protection Agency's (EPA) final non-cancer assessment of dioxin is the latest effort in a successful, coordinated strategy by the Federal government that has reduced industrial dioxin emission levels by about 90 percent since 1987.
- Dioxin appears in the environment from natural and man-made sources, largely through forest fires, backyard burning of trash, commercial burning of waste or land disposals by industry. When released into the environment, dioxin can concentrate in the food chain.
- Working together, EPA and other Federal agencies have identified, then controlled or eliminated, many known sources of dioxin. As a result, today, most Americans have low-level exposure to dioxin and findings show that generally, over a person's lifetime, current exposure to dioxin does not pose a health risk.
- Using the best, current science as the basis for its cleanup actions, EPA has developed an implementation approach for using the new reference dose (RfD) for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) to develop Superfund and Resource Conservation and Recovery Act (RCRA) cleanup levels.

**Q&A:**

**How will the new 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) Reference Dose (RfD) impact the cleanup of dioxin-contaminated sites?**

Using the best, current science as the basis for its cleanup actions, EPA will use the new RfD to address new cleanups and will re-evaluate previously investigated/cleaned up sites under Superfund and RCRA to determine if additional sampling or cleanup may be needed to protect public health. In all cases, EPA's goal is protection of human health and the environment, and that goal remains the same as new scientific changes comes to light.

- Evaluating previously investigated/cleaned up sites will be undertaken by each EPA region and time to implement will depend on the number and complexity of sites within each region.
- Using existing EPA guidance, the RfD will be used to develop site-specific risk-based cleanup levels at CERCLA and RCRA sites.
- Dioxin-contaminated sites cleaned up based on the new non-cancer RfD are not expected to need additional cleanup when a new EPA cancer toxicity value for dioxin is published in EPA's Integrated Risk Information System (IRIS). This is because dioxin cleanup levels based on the new RfD are within the cancer risk range currently used by EPA's Superfund and RCRA cleanup programs.

**How will the new RfD impact state cleanup programs?**

State programs are not required to implement the new RfD. In fact, many of these programs have already established their own dioxin cleanup levels that are more stringent than a residential soil cleanup level

based on the new RfD and EPA risk assessment methods. EPA will continue to work closely with states, particularly with states that are co-regulators managing federal cleanup programs, as EPA implements cleanup actions based on the new dioxin RfD.

#### **How will EPA address previously evaluated sites?**

EPA will identify, prioritize and evaluate sites previously investigated or addressed for dioxin to determine if new monitoring/sampling information is needed. EPA will prioritize these sites by reviewing the following information:

- Existing monitoring/sampling information and other site data.
- Current and future land use - priority is given to residential areas.
- Environmental justice concerns.
- Community/property owner input.
- Local, state, and tribal government input.
- The possibility that contamination may exist beyond the original cleaned up areas

This effort will be undertaken by each EPA region and time to implement will depend on the number and complexity of sites within each region.

#### **Will additional cleanups be needed when the Agency releases the dioxin reassessment cancer results?**

Dioxin-contaminated sites cleaned up based on the new non-cancer RfD are not expected to need additional cleanup when a new EPA cancer toxicity value for dioxin is published in EPA's Integrated Risk Information System (IRIS). This is because dioxin cleanup levels based on the new RfD are within the cancer risk range currently used by EPA's Superfund and RCRA cleanup programs. The new dioxin non-cancer RfD will allow federal cleanup programs to incorporate the best, current science regarding dioxin toxicity and ensure that site cleanups are protective of human health and the environment.

### **DIOXIN TOXICITY**

#### **What are the new soil dioxin preliminary remediation goals (PRGs), based on the new RfD and default exposure factors?**

Consistent with the National Contingency Plan's (NCP's) preamble (see e.g., 55 Fed. Reg. 8666 at p. 8745 (March 8, 1990) and subsequent guidance (EPA 2003), the IRIS RfD is an appropriate toxicity value to use for establishing exposure levels that are protective of human health. Thus, this RfD is now the recommended value "to be considered" (TBC) for use in developing site-specific dioxin PRGs and cleanup levels under CERCLA and the NCP. Preliminary remediation goals are risk-based concentrations in media that are used as a starting point in developing cleanup levels. For example, the PRG calculated using the new RfD of 0.7 pg/kg-day (picogram per kilogram-day) and EPA default exposure factors is 50 part per trillion (ppt) toxicity equivalence (TEQ) for residential soil and 665 ppt TEQ for commercial/industrial soil. If the Regions have adequate data they can derive PRGs and cleanup levels using site-specific exposure factors instead of the national default factors. With the release of the Tier 1 IRIS RfD for TCDD, the Agency no longer has a need for the PRGs for dioxin in soil recommended in EPA's 1998 *Approach for Addressing Dioxin in Soil at CERCLA and RCRA Sites* (EPA 1998) or the proposed interim PRGs provided in the December 30, 2009 *Draft Recommended Interim Preliminary Remediation Goals for Dioxin in Soil at CERCLA and RCRA Sites*.

#### **The new RfD is only for TCDD. How should other dioxin-like compounds (DLCs) be addressed?**

TCDD and dioxin-like compounds (DLCs) (which include polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (PCBs)), typically occur as mixtures in environmental media. The toxicity of DLCs can be addressed by considering their toxicity

relative to TCDD. EPA recommends using recently updated Toxicity Equivalence Factors (TEFs) to assess human health risks from exposure to dioxin-like compounds (EPA 2010a). A TEF for a DLC is a measure of the compound's toxicity relative to TCDD, which is assigned a TEF of 1. For example, 1,2,3,4,7,8-hexachloro-dibenzo-p-dioxin is considered one-tenth as toxic as TCDD and has therefore been given a TEF of 0.1.

TEFs are used to determine the dose, or concentration in the media, scaled to account for the toxicity of the individual DLC relative to TCDD. This dose is presented in terms of toxicity equivalence (i.e., TCDD TEQ). To apply TEFs, the exposure concentration of a single DLC measured in an environmental sample is multiplied by its corresponding TEF, yielding a dose for the DLC that is equivalent to a dose of TCDD. Total TEQ for the mixture in the sample is the sum of the individual TCDD TEQs for the DLCs. For additional information on the TEFs, see EPA's Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds (EPA 2010a).

## **DIOXIN EXPOSURE**

### **What are typical background levels for dioxin in soil?**

A recent study by EPA (EPA 2007) indicates that the concentration of dioxin in rural U.S. soils ranges from 0.2 to 11.5 ppt TEQ, with an average of 1.8 ppt TEQ. A recent survey of literature on dioxin concentrations in U.S. urban areas (Lambert, SETAC 32nd Annual Meeting, 2011a) indicates there is greater variability in urban areas than in rural areas. Background concentrations in urban soils were found to range from 0.2 to 200 ppt TEQ: the median of reported medians is 6 ppt TEQ; the 75<sup>th</sup> percentile of the reported median values is 6.8 ppt TEQ and of reported maximum values is 35.3 ppt TEQ; and the 95<sup>th</sup> percentile of reported values is 110 ppt TEQ. Concentrations below 0.2 ppt TEQ are not readily determined, due to analytical constraints. Generally, it is EPA policy at CERCLA sites to determine site-specific background levels and not to clean up to concentrations below natural or anthropogenic background levels (EPA 2002).

## **APPLICATION OF THE RfD AT CERCLA AND EPA-LEAD RCRA CORRECTIVE ACTION SITES**

### **To which environmental media does the new RfD apply?**

The new oral RfD may be used for dioxin-contaminated environmental media, such as soil, dust, sediments, or fish tissue.

### **What cleanup levels should be used to address dioxin in drinking water?**

The Federal maximum contaminant level (MCL) for dioxin in drinking water is 30 pg/L (picogram per liter). For the cleanup of groundwater designated as a drinking water source, the MCL should continue to be considered as a potential applicable or relevant and appropriate requirement (ARAR) under CERCLA (and cleanup level under RCRA), unless a State or Tribe has a more stringent drinking water standard.

### **What cleanup levels should be used to address dioxin in surface water?**

The Federal ambient water quality criteria (AWQC) for dioxin in surface water is 5.0E-9 ug/l (microgram per liter) for water and organisms and 5.1E-9 ug/l for only organisms. The AWQCs should continue to be considered as potential ARARs (and cleanup levels under RCRA) for the cleanup of surface water, unless a State or Tribe has a more stringent standard.

### **Does EPA have guidance on sampling dioxin?**

OSWER has recommended an incremental composite sampling (ICS) approach for dioxin-contaminated soils and sediments. Guidance on the ICS approach and a Uniform Federal Policy – Quality Assurance

Project Plan are available on EPA's website:

<http://www.epa.gov/superfund/health/contaminants/dioxin/dioxinsoil.html>

### **Does EPA have guidance on how to handle dioxin-contaminated waste?**

The *Fact Sheet on the Management of Dioxin Contaminated Soils* (EPA 2010b) provides guidance on the management of dioxin-contaminated waste at CERCLA sites.

### **APPLICATION OF THE RfD AT TRIBAL, STATE, AND BROWNFIELD SITES**

#### **How will the new RfD and dioxin TEFs impact non-Federal cleanup programs, such as Tribal, State, Brownfield or local cleanup programs?**

Non-federal cleanup programs, such as tribal cleanup programs, state voluntary cleanup programs, state Superfund programs, and brownfields and local cleanup programs will not be required to adopt or use the new dioxin RfD. In fact, some of these programs have already established dioxin cleanup levels for various media and can continue to use these levels for their intended purpose. For example, 15 states have soil dioxin cleanup levels more stringent than a residential soil cleanup level based on the new RfD and default exposure parameters (50 ppt TEQ)(EPA 2009a).

With respect to states with delegated RCRA Corrective Action programs, they can use the new oral RfD for dioxin as they implement their delegated response programs under RCRA, but will not be required to do so.

Fewer than 60 of the thousands of brownfields properties that have received EPA grants have reported dioxin as a contaminant of concern at any level. In the context of State Voluntary Cleanup Programs, the state program requirements would govern the cleanup, even if sampling plans were also submitted to EPA. Regional staff would comment where they had questions or concerns. The new oral RfD would serve only as a reference point for the State response program and would not be required. When a State or tribal program oversees assessment or cleanup, a brownfield grantee may be directed to sample and test for dioxin by their State or tribal program regulators based on site assessment results or additional information. When the site assessment indicates dioxin may be a contaminant of concern, a brownfield grantee will test for dioxin based on recommendations of the environmental professional, similar to the accepted practice at Superfund sites. Based on past grantee reporting, EPA does not believe a change in the dioxin RfD will have an appreciable impact on brownfields redevelopment given the limited number of dioxin-contaminated sites identified with assessment or cleanup grant funds.

#### **If emission rates, dietary intake and body burdens are on the decrease in the United States primarily because of actions that EPA has taken over the last 20 years to control dioxin releases into the environment, why do EPA's cleanup programs need to use this new dioxin toxicity information to establish updated cleanup levels?**

CERCLA and RCRA programs focus on contaminated sites where contaminants, such as dioxins, are present at elevated environmental concentrations compared to typical background levels. While EPA recognizes that, from a national standpoint, emission rates, dietary intake and body burdens are trending downward for the U.S. population as a whole, people living at or near dioxin-contaminated waste sites may have a relatively higher exposure to dioxins. This is particularly true for individuals who, over an extended period of time, are exposed to dioxin-contaminated soils, garden or farm products and fish or wildlife that may have significantly greater dioxin levels than those found in the commercial food supply, due to the presence of site-related dioxin contamination. Individuals in this situation receive potentially greater exposure and are potentially at a greater risk than the general population. Cleaning up dioxin contamination to levels based on the new TCDD RfD may allow those who live at or near dioxin-contaminated sites, and who have a relatively higher exposure to dioxins, to benefit from the same decreases in dioxin exposure and reduced environmental risks that the overall U.S. population has been experiencing. Additional information on exposure to dioxin is available at:

<http://www.fda.gov/Food/FoodSafety/FoodContaminantsAdulteration/ChemicalContaminants/DioxinsPCBs/ucm077524.htm>

## **DIOXIN TOXICITY**

**What is the new non-cancer toxicity value for TCDD that was placed in EPA's IRIS on February 17, 2012?**

On February 17, 2012, EPA placed in IRIS an oral reference dose (RfD) of 0.7 picogram per kilogram-day (pg/kg-day) for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). More information on the basis for the development of this toxicity value is available at: <http://www.epa.gov/iris/supdocs/1024index.html>

## **DIOXIN EXPOSURE**

**How does someone get exposed to dioxin? How and where does this exposure occur?**

Dioxin from natural and anthropogenic (man-made) sources has been widely distributed throughout the environment. Most of the population has low-level exposure to dioxin. Although dioxin is an environmental contaminant, most dioxin exposure occurs through the diet. While we all likely have some level of dioxin in our body, the levels are low and findings show that low levels of exposure do not pose a health risk.

**What advice can be given regarding children or pets playing in areas undergoing re-evaluation?**

If a yard was one in which soils were removed and replaced with clean fill as part of a past cleanup action, then it is not expected to pose public health concerns.

For properties where dioxin contamination in the past was sampled, but no cleanup action was determined to be necessary, the EPA will be reviewing historic site records, sampling data, and current land use to determine whether additional sampling and/or cleanup actions are required to protect human health. If a yard is in an area undergoing re-evaluation, there are general good practices that can be followed when children play outdoors:

- When children playing outside, they should be discouraged from eating dirt or putting toys, their hands or other objects in their mouths.
- Children should not play in soils that are known or suspected to contain elevated levels of chemical contaminants.
- Bare soil areas should be covered with grass, mulch or some other covering to minimize direct contact with the soils
- Be sure to have children wash their hands, especially before eating or drinking, and be sure to have children wash up thoroughly after playing outdoors.
- Remove children's footwear before they enter the house and manage other items in a way that limits the amount of potentially contaminated soil that may be carried into the house.

Animals that spend time both outdoors and indoors should be provided with a clean area for outdoor activities and should be prevented from tracking soil into the house.

**What advice can be given regarding gardening in areas undergoing evaluation?**

Because dioxin compounds do not readily dissolve in water, plants do not appreciably take up dioxins through their roots. However, dioxin-contaminated soil particles may stick to fruits and vegetables; they should therefore be carefully washed and/or peeled before they are consumed. In addition, there are additional general good practices that gardeners can take:

- Control dust by gardening when soil is moist and under favorable wind conditions, thus minimizing inhalation and swallowing of airborne soil particles and dust.

- Wash dirt and mud from items like outerwear, gardening tools and supplies outside after each use, and store them outside.
- Designate certain clothing, including footwear and tight fitting disposable gloves for gardening use only. Remove footwear before entering the house and manage gardening clothes in a way that limits the amount of contaminated soil that may be carried into the house.
- After gardening, wash all exposed areas of skin, preferably by showering, as soon as possible.
- Do not drink, smoke or engage in other activities while gardening that may introduce soil into the mouth.
- If dioxin contamination is known or suspected in soils around your home, clean fill soil can be placed over the contaminated soil. Garden beds can be raised and replaced with clean soil. Care should be taken not to disturb the layer of clean soil covering the contaminated soil.

## **APPLICATION OF THE RfD AT CERCLA AND EPA-LEAD RCRA CORRECTIVE ACTION SITES**

### **Does re-evaluation of sites mean that EPA's past cleanups were done incorrectly?**

No, re-evaluation of sites does not mean that EPA's past cleanups were not done properly. EPA undertook dioxin cleanups using the best available scientific information at that time resulting in significant reductions in risk to residents or workers. However, since those cleanups, scientific advances have been made regarding dioxin's toxicity. EPA routinely responds to changing chemical toxicity information. For example, under the Superfund statute (CERCLA Section 121 (c)) EPA is required to evaluate remedy protectiveness at least once every five years whenever contamination has been left in place at Superfund remedial sites. The new RfD will be used to re-evaluate previously investigated or remediated properties (including CERCLA removal, CERCLA remedial sites, regardless of whether a five-year review is required, and EPA-lead RCRA corrective action sites) to determine whether additional appropriate response is needed to help ensure continued protection of human health and the environment.

### **Will the new RfD and TEFs be used to identify new sites and list new sites on the NPL (National Priorities List)?**

At sites where EPA believes there has been a release of dioxin or other dioxin-like compounds (DLCs)(e.g. wood treater sites), EPA will use the new oral RfD, the procedures in the National Contingency Plan and existing policy and guidance in evaluating sites and determining whether to propose a site for the National Priorities List (NPL).

### **Will the new RfD and TEFs be used for CERCLA five-year reviews and deletions?**

Yes, the new RfD will be used during the CERCLA five-year review and deletion process. The dioxin cleanup levels selected in the remedy decision document and documented post-cleanup site conditions will be evaluated using the new RfD. EPA will determine if the cleanup level selected is still within the acceptable risk range and post-cleanup site conditions are protective for current and future exposure scenarios at the site. A similar evaluation will be conducted during the site completion and deletion process.

### **What will be done to evaluate former dioxin assessments and cleanups that are now public-use properties, such as Times Beach, Missouri, which is now a state public park? How long will this take, bearing in mind that homeowners may be essentially unable to sell their homes until a determination is made? How will EPA prioritize which sites get re-evaluated?**

EPA will be re-evaluating the assessments and cleanups that were conducted at dioxin-contaminated sites, including the former Times Beach Superfund site, to ensure that the cleanups remain protective through appropriate response, where deemed necessary, in light of EPA's new dioxin toxicity information. EPA will review these sites in a systematic fashion, considering a number of factors, such as: existing site data; land use; environmental justice concerns; community and property owner input; local, state, and tribal government input; and the probability that contamination may exist beyond the original cleaned up areas. If at any time an imminent and substantial endangerment situation is identified, EPA may respond

using its CERCLA or RCRA authorities, as appropriate. This effort will be undertaken by each EPA region and time to implement will depend on the number and complexity of sites within each region. Homeowners can find information on EPA's website that will assist them in contacting their regional EPA office for assistance.

### **What is the impact of the new RfD and TEFs on addressing principal threat waste at CERCLA sites?**

It is EPA's expectation that, consistent with CERCLA and the NCP, Superfund cleanups for a site will generally involve treatment of the principal threats and containment of the remaining low level material (40 CFR 300.430(a)(1)(iii)). Although no "threshold level" of risk has been established to identify principal threat waste, a general rule of thumb is to consider as a principal threat those source materials with toxicity and/or mobility characteristics that combine to pose a potential risk several orders of magnitude greater than the risk level that is acceptable for the current or reasonably anticipated future land use, given realistic exposure scenarios (EPA 1991, EPA 1995).

### **How do I evaluate dioxin-like PCBs at PCB sites?**

The TCDD RfD can be used for other dioxin-like compounds (which include polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (PCBs)), by applying the dioxin toxicity equivalence factors (TEFs). However, the new RfD for TCDD is not expected to have a significant impact on CERCLA and EPA-lead RCRA corrective action PCB sites, because the concentration of dioxin-like PCBs in PCB-contaminated soil generally is not high. The new oral RfD also is not expected to impact the cleanup of PCB-contaminated sediments sites where the fish ingestion pathway is the basis for the cleanup. This is because site-specific risk-based sediment concentrations estimated to be protective for humans from the fish ingestion pathway are already often below site background levels and it is EPA policy not to cleanup below background.

If dioxin-like PCBs are of concern at a PCB site, the PCB cleanup level will need to be developed so that it is protective for the dioxin TEQ cleanup level. The PCB cleanup level that will meet a site-specific dioxin TEQ cleanup level depends on the concentration of dioxin-like PCBs in the PCB-contaminated media along with any TCDD and other DLCs present. For example, the PCB soil cleanup level that will meet a specific dioxin TEQ soil cleanup level can be calculated as:

$$\text{PCB}_{\text{cleanup level for DLCs}} = \text{PCB}_{\text{soil concentration}} \times \text{TEQ}_{\text{cleanup level}} / \text{TEQ}_{\text{soil concentration}}$$

This value would need to be compared to the site-specific PCB soil cleanup level to select the more stringent of the two to ensure the remedy will be protective for both PCB and dioxin-like PCB (along with any TCDD and other DLC) exposures.

## **BROWNFIELDS ISSUES**

### **How typical is dioxin as a contaminant at brownfield sites?**

Dioxin is not a typical contaminant at brownfield sites due in part to the nature of the commercial and industrial activities at brownfield sites and to these sites' smaller size and less contaminated nature. Based on an updated review of the Program's Grants data, fewer than 60 properties of the thousands funded by EPA's brownfields grants have reported dioxin as a contaminant of concern and those were largely reported under cleanup activities overseen by State and Tribal environmental response programs.

### **Do state and tribal response programs typically regulate dioxin cleanups?**

State and tribal programs typically regulate and oversee cleanup of brownfield sites contaminated with dioxin. Tribal, state and local cleanup programs may have already established dioxin cleanup levels for various media and are expected to continue to use the established levels for their intended purpose. For

example, many of these states already have residential dioxin soil cleanup levels more stringent than soil cleanup levels based on the new RfD and default exposure factors.

**Brownfield cleanups under state and tribal response programs have been ongoing for many years. Should communities take any affirmative steps to reexamine prior cleanup actions taken, to ensure they are protective?**

Cleanup activity conducted under State and Tribal environmental response programs were done in light of the applicable regulations and requirements in the context of the anticipated site reuse. The EPA recommends that communities concerned about dioxin at a specific brownfield site contact the State and Tribal environmental response program that regulates and oversees cleanups, to learn about the soil cleanup levels and to consider the information relative to the ongoing or planned-use activity at the site. Where dioxin is expected to be a contaminant of concern, EPA recommends local, State and Tribal authorities discuss the new RfD, in keeping with local community involvement practices, as part of brownfield or other site cleanup and redevelopment programs. We do not anticipate that the new RfD will have an appreciable effect on brownfield development.

## **APPLICATION OF THE RfD AT SPECIFIC SITES**

**How might issuance of EPA's non-cancer reassessment of dioxin affect past actions and future decisions at the Tittabawassee River, Saginaw River & Bay site in Michigan?**

To date, actions taken at the CERCLA portion of the site include removal of dioxin-contaminated sediments and soil along the Tittabawassee River, removal of dioxin-contaminated sediments in the Saginaw River, and measures taken to mitigate exposure to dioxin-contaminated flood plain soil in the near-term along the Tittabawassee River. In the future, a site-wide risk assessment will be conducted, using IRIS toxicity values including the new RfD, as available, to determine if additional cleanup is needed in areas where actions have already been taken.

**At which new sites will the RfD for TCDD be used?**

The RfD is to be used at all new CERCLA and RCRA sites (as well as all previously investigated/cleaned sites). For example, currently there are six CERCLA sites in the cleanup decision-making process where the new RfD is expected to be considered: Tittabawassee River, Saginaw River & Bay site, MI; Centredale Manor Restoration Project site, RI; St. Regis Paper Company site, MN; Lower Passaic River Restoration Project site, NJ; Kanawha River site, WV; and American Creosote Works Inc. (Winn Parish), LA.

## **USE OF THE RfD IN RISK ASSESSMENTS**

**What is OSWER's recommendation regarding a national default relative bioavailability factor (RBA) when estimating site-specific screening levels, PRGs, or cleanup levels for soil based on the new RfD?**

Because of scientific uncertainties in the currently available data for bioavailability of dioxin and DLCs in soil, OSWER does not recommend using a national default bioavailability factor to develop cleanup levels for dioxin and other DLCs. Superfund risk assessments generally have relied on site-specific estimates of relative bioavailability. In these cases, the animal models and experimental procedures have been developed and refined such that reliable site-specific estimates of relative bioavailability are supportable. For dioxin, additional research is needed to define appropriate animal models and clarify the influence of congener chlorination and soil properties on bioavailability. When this information becomes available, an appropriate bioassay protocol would need to be developed to support the development of site-specific estimates of relative bioavailability for dioxin. OSWER encourages the research that would address these issues. EPA has conducted a literature review of the available soil dioxin RBA studies. The range of soil dioxin RBAs, based on rat studies, was from 11% to 68%, and based on swine studies, from 23% to 49%.

This review has undergone peer review and can be found at <http://www.epa.gov/superfund/health/contaminants/dioxin/dioxinsoil.html>.

### **How can relative bioavailability of dioxin in soil be considered?**

The relative bioavailability of dioxin in media is determined on a site-specific basis.

### **How can relative bioavailability of dioxin in sediments be considered?**

For sediments, bioavailability typically refers to the disposition of the contaminants in the sediment (i.e., are contaminants bioavailable or are they very tightly bound?). When projections of exposure from sediments are made, site-specific estimates of bioavailability are needed. For example, fish tissue contaminant concentrations are often estimated by using foodweb bioaccumulation models. These models rely on equilibrium partitioning theory to describe the bioavailability of contaminants in sediments, which in turn feed into estimates of contaminant uptake through the food chain. Alternatively, the concentrations of contaminants in organisms can be predicted using empirically-derived site-specific relationships between sediment and the organism (a biota-sediment accumulation factor [BSAF]). In this case, the BSAF is developed based on previous measurement of actual sediment and organism contaminant concentrations and no bioavailability adjustment is needed.

### **Can the new RfD be used for other exposure pathways in addition to oral exposure?**

**Ingestion.** Generally, the ingestion pathway for TCDD and other DLCs drives risk assessments. The oral RfD can be used for evaluating the risk posed by the ingestion of soil, sediments, and fish contaminated with TCDD and other DLCs. The Federal maximum contaminant level (MCL) for dioxin in drinking water is 30 pg/L (picogram per liter). For the cleanup of groundwater designated as a drinking water source, the MCL should continue to be considered as a potential applicable or relevant and appropriate requirement (ARAR) under CERCLA (and cleanup level under RCRA), unless a State or Tribe has a more stringent drinking water standard.

**Dermal exposure.** In the absence of dermal toxicity values, a route-to-route (oral to dermal) extrapolation can be done using the oral toxicity value and adjusting for absorption through the skin. This OSWER policy is described in Section 4.1 of EPA's *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final* (EPA 2004b). The availability of a dermal absorption factor for TCDD allows for the use of the new oral RfD in evaluating dermal exposure (see Attachment B, (EPA 2004b), which includes the dermal absorption factor (0.03 pg absorbed/pg of skin) and the gastro-intestinal absorption fraction (1 pg absorbed/pg ingested) for dioxin).

**Inhalation.** IRIS does not include toxicity values for estimating the risk posed by the inhalation of TCDD (either via particulates or volatiles). Inhalation risk estimated using CalEPA's RfC (reference concentration) for TCDD based on particulate emissions shows that the contribution of the inhalation pathway is well below 1% (EPA 2012). Inhalation exposure to dioxin (from vapor originating in soil) is expected to be low (< 2.4%) compared to oral exposure in most cases (see Attachments A and B). Therefore, the risks due to inhalation of particulates and vapors from soil are expected to be minimal.

The EPA Regional Screening Level tables (RSL) (EPA 2012) provide dioxin screening levels for a variety of pathways and exposure scenarios for a number of media. The RSL tables are usually updated twice a year to address any toxicity changes.

### **How should TCDD cancer risks be evaluated?**

The evaluation of TCDD cancer risks at CERCLA and RCRA sites does not change with the issuance of the IRIS RfD. Superfund has established a hierarchy of toxicity values; IRIS toxicity values have been designated Tier 1 (EPA 2003). In the absence of an IRIS value, EPA evaluates other sources of toxicity values. For dioxin, the Agency has considered EPA's Health Assessment Document cancer slope factor

(CSF) for dioxin and California EPA's dioxin CSF. The NCP requires us to consider both cancer and non-cancer risks.

**Now that there is a Tier 1 non-cancer toxicity value for TCDD in IRIS, do the Regions still need to consult with Headquarters on dioxin sites?**

Yes, where cleanup decisions have not been made, the Regions should continue to consult with EPA Headquarters. Specifically, at CERCLA NPL sites, including, where appropriate, other Federal agency-lead and State-lead sites, the Regions should consult with the Assessment and Remediation Division in the Office of Superfund Remediation and Technology Innovation (OSRTI) on all proposed cleanups involving dioxin (EPA 1996). Consultation should be initiated at the risk assessment stage and continue throughout the remedy selection process. OSRTI will include the Federal Facilities Restoration and Reuse Office (FFRRO) in the consultation on Federal agency-lead sites. For removal actions, the Regions should contact the Office of Emergency Management (OEM) for concurrence on non-NPL removal actions where dioxin is a principal contaminant of concern (EPA 2009b). Where EPA is the lead for RCRA corrective action sites, Regions should provide ORCR with proposed dioxin cleanup levels (i.e., prior to notice and comment).

**Will the new RfD be incorporated in the Regional Screening Level tables?**

Yes. The Regional Screening Level tables are available at: [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/)

The RSL tables are usually updated by EPA twice a year. The next update, expected in Spring 2012, will include new dioxin screening levels based on the new RfD.

**How would the RfD be used in calculating a risk-based cleanup level?**

Based on existing EPA guidance, toxicity values, such as reference doses, are used to develop cleanup levels at CERCLA and RCRA sites. Information on conducting risk assessments at CERCLA sites can be found at: [http://www.epa.gov/oswer/riskassessment/risk\\_superfund.htm](http://www.epa.gov/oswer/riskassessment/risk_superfund.htm) and at RCRA sites, at: [http://www.epa.gov/oswer/riskassessment/risk\\_rcra.htm](http://www.epa.gov/oswer/riskassessment/risk_rcra.htm)

**DIOXIN TOOL BOX QUESTIONS AND ANSWERS**

**How do I use the dioxin and furan analytical services offered by OSRTI's Analytical Services Branch?**

EPA's Analytical Services Branch (ASB) has pre-qualified laboratories that use the Dioxin and Furan Statement of Work (SOW) (DLM02.X) to provide this service under Blanket Purchase Agreements (BPAs). The BPAs are managed by ASB and the Office of Acquisition Management (OAM). Regional customers utilize a "buy-in" process to acquire analytical services and a "Request for Quote" is used to determine award. The dioxin and furan analytical service can be requested by EPA regional personnel by submitting a Task Order (TO) to OSRTI's ASB. Contact Charlie Appleby, NRAS (Non-routine Analytical Services) Program Manager, at (703) 347-0266 for more information.

**What congeners are measured in what matrices and to what detection limits?**

The dioxin and furan analytical service applies EPA analytical methods for the isolation, detection, and quantitative measurement of seventeen 2,3,7,8-substituted tetra- through octa-chlorinated dibenzo-dioxins (CDDs) and chlorinated dibenzo-furans (CDFs) in water, soil, sediment, sludge, non-human tissue, ash, oil, and oily matrices. For water samples, the lowest reportable CRQL (contact required quantitation limit) is 10.0 pg/L. For solid samples, the lowest reportable CRQL is 1.0 ng/kg. Since CRQLs are highly matrix and moisture dependent, the quantitation limits in the SOW are provided for guidance only and may not always be achievable.

**Where can I find more information about the analytical methods, quality assurance processes, and quality control processes with respect to the dioxin and furan analytical services offered?**

Additional information about the methods is provided in Exhibit D of the SOW, which is available at: <http://www.epa.gov/superfund/programs/clp/dlm2.htm>.

Detailed QA/QC procedures for this analytical service are provided in Exhibit E of the SOW, which is available at: <http://www.epa.gov/superfund/programs/clp/dlm2.htm>.

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## ATTACHMENT A

### EVALUATION OF RELATIVE DIOXIN INTAKE FROM INHALATION AND INGESTION EXPOSURE

Exposure to a contaminant in soil may occur by a number of pathways, including direct ingestion of soil, dermal contact with soil, inhalation of soil particulates in air, and inhalation of volatile chemicals released from the soil to air. This Attachment compares the relative magnitude of human exposure to dioxin in soil by the inhalation route (i.e., inhalation of dioxin vapor) compared to the intake by the oral route using EPA's default residential and commercial/industrial land exposure parameters. The dermal pathway is not included in the comparison because dermal exposure is expressed in terms of absorbed dose, while the oral and inhalation pathways are expressed in terms of administered dose. However, based on default exposure assumptions, the dermal pathway is relatively minor compared to the oral pathway. This Attachment does not compare risks associated with oral and inhalation pathways because there is no available EPA inhalation unit risk value for TCDD.

#### Relative Contribution from Inhalation of Volatiles

The ratio of the daily intake of a chemical due to inhalation of the volatilized chemical to the chemical ingested on soil is calculated as:

$$\text{Ratio}(\text{inhal}/\text{ingest}) = \text{BR} / (\text{IR} \cdot \text{VF})$$

where VF = volatilization factor ( $\text{m}^3/\text{kg}$ ).

The value of the VF term may be calculated using Equation 4-8 in EPA (2002). Recommended default inputs and chemical-specific terms for TCDD are shown in Table A-1 of EPA (2002). Based on these parameters, the value of VF is estimated to be  $8.4\text{E}+06 \text{ m}^3/\text{kg}$ . For other more volatile congeners, the value of VF may be lower, but when adjusted for relative toxicity, it is expected that the contribution of other congeners will be minor. Based on this, and the recommended default values for the breathing rate and soil ingestion rate for residents and workers (EPA, 1991), the ratios of dioxin intake from vapor inhalation compared to soil ingestion are as follows:

Parameter	Parameter Value		
	Child	Adult	Worker
BR ( $\text{m}^3/\text{day}$ )	10	20	10
IR ( $\text{kg}/\text{day}$ )	2E-04	1E-04	1E-04
VF ( $\text{m}^3/\text{kg}$ )	8.4E+06	8.4E+06	8.4E+06
<b>Ratio (inhalation of vapors vs. oral intake)</b>	<b>0.006</b>	<b>0.024</b>	<b>0.012</b>

As seen, exposure by inhalation of dioxin released to air from soil is likely to be small (< 2.4%) compared to the amount of dioxin ingested in soil.

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## ATTACHMENT B

### RECOMMENDED EQUATION FOR COMPUTING NON-CANCER PRELIMINARY REMEDIATION GOALS FOR EXPOSURE OF RESIDENTS TO DIOXIN IN SOIL

$$PRG \text{ (pg / g)} = \frac{THQ \cdot BW \cdot AT \cdot 365 \text{ days/yr} \cdot RSC}{EF \cdot ED \cdot [IR_{soil} \cdot RBA / RfD_o + (AF \cdot ABS_d \cdot EV \cdot SA) / (RfD_o \cdot ABS_{GI})]}$$

Parameter (description)	Units	Default Value
THQ (target hazard quotient)	Dimensionless	1
BW (body weight - child)	Kg	15
AT (averaging time)	Years	6
EF (exposure frequency)	days/yr	350
ED (exposure duration)	Years	6
RfD <sub>o</sub> (oral reference dose)	pg/kg-day	0.7 (a)
IR <sub>soil</sub> (soil ingestion rate)	g/day	0.20
ABS <sub>GI</sub> (gastrointestinal absorption fraction)	pg absorbed/pg ingested	1.0
AF (dermal adherence factor)	g/cm <sup>2</sup>	2E-04
ABS <sub>d</sub> (dermal absorption fraction)	pg absorbed/pg on skin	0.03 (b)
EV (dermal exposure frequency)	events/day	1
SA (dermal surface area exposed - child)	cm <sup>2</sup>	2,800
RBA (relative bioavailability)	--	1
RSC (relative source contribution)	--	1

Source: EPA 2002 Equation 3-2

Includes oral and dermal exposure.

(a) Based on EPA's new IRIS RfD for TCDD (EPA 2012)

(b) Based on EPA (2004)

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